ix. Insertion Power Supplies

Overview

The insertion power supplies - these include the shunts to the insertion dipoles, D0 and DX, the shunts to the insertion quadrupoles, Q1-3, and Q6-9 and the trim quadrupole supplies at CTQ4, 5, and 6. They were specified in modular sizes to minimize the quantity of types of supplies to maintain, and to simplify procurement. All of the insertion power supplies are located in the service buildings. The types and quantities of IR power supplies are listed in Table 2-7.

Monopolar Insertion Power Supplies

The monopolar insertion power supplies are current regulated DC power supplies with an inner voltage loop. The AC input to these power supplies is 3 Phase 480VAC for the 2000A and 600A units. The AC input to the rest of the lower current units is 3 phase 208VAC. All of the monopolar power supplies utilize a 12 pulse SCR bridge Power Converter with an output LCRC filter. The current sensing element for current feedback to the current regulator is a DCCT. The required reproducibility is 0.01% of the maximum output current. All of these power supplies have a 100% and 50% voltage tap setting.

Bipolar Insertion Power Supplies

The Bipolar insertion power supplies are also current regulated DC power supplies with an inner voltage loop. However, the bipolar supplies utilize a switchmode DC-DC converter which is controlled by a tracking voltage loop. This tracking voltage loop is in addition to the power supply voltage loop. The DC-DC Converter is a Pre-Regulator for a MOSFET Output Power stage. The voltage across the MOSFET Output power stage is fed back to this tracking voltage loop which keeps the voltage across the MOSFET Power stage low so as to reduce power dissipation across these MOSFETS. The MOSFET Output power stage is an H-bridge configuration. Two of the MOSFETS act linearly while the other two MOSFETS act like a switch controlling which direction the current flows through the magnet load. The number of MOSFETS in the Output Stage of the bipolar 150A power supplies is 24 and the number of MOSFETS in the Output Stage of the bipolar 300A power supplies is 48. The input to these power supplies is 3 phase 208VAC.

Table 2-7. Power Supply Summary

Item	Polarity	Voltage (V)	Current (A)	Quantity (2 rings)
Main Power Supplies				
Quad H/V Trim	mono	40	300	2
Insertion Dipoles				
Type A	mono	20	2000	14
Type B	mono	20	600	7
Insertion Quadrupoles				
Type A	bi	15	150	96
Type B	bi	15	300	14
Type C	mono	15	200	48
Type D	mono	15	300	24
Type E	mono	15	450	16
Type F	mono	20	600	16

Nesting of Monopolar and Bipolar Insertion Power Supply Systems

In any sextant of RHIC there can be as many as 7 power supplies nested inside one power supply. Due to this nesting, all of the insertion power supplies must float off of ground. The DC Output terminals of the 2000A and 600A power supplies have been put through high potential testing of 2500VDC because they are on the Dipole Circuit which has a much higher inductance than the quadrupole circuit. For this reason the 2000A and 600A power supplies will float off of ground to a higher voltage. The lower current units have been put through high potential testing of 1600VDC because they are on the quadrupole circuit which floats off of ground to a voltage which is lower than the dipole circuit.

The nesting of the insertion power supplies and the use of superconducting magnets also created complex time constants which made it very difficult to stabilize the current loops of these power supplies. In some cases the measured admittance of the load was not a pure inductance but also had some capacitive components.

Insertion Power Supply Control System

All of the insertion power supplies use the same 3u chassis control bucket. In this control bucket resides the fiber optic interface card, the current regulator card, the buffer card, the DCCT electronics card, the voltage regulator card, the digital isolation card and the control card. The fiber optic interface card receives the power supply current setpoint over fiber and converts it to an analog current setpoint utilizing a 16bit D/A. This analog setpoint is sent over the 3u control chassis backplane to the BNL designed current regulator card. This current regulator card has a removable PC board for adjusting time constants to stabilize the power supply current loop. The buffer card sends four analog signals back to the Multiplexed Analog to Digital Converter (MADC). These four signals are power supply current setpoint, output current, output voltage and power supply current error. The DCCT electronics card and voltage regulator card were purchased from an outside vendor. The voltage regulator card also contains the isolated shunt feedback voltage which is used in the DC overcurrent circuit which is built into the voltage regulator card. The digital isolation card receives commands from a Node card which is external to the power supply and sends power supply statuses back to this Node card. The Node card communicates over a MODBUS Plus network to a MODICON Programmable Logic Controller (PLC). This PLC communicates with the front end VME computer over an Ethernet connection. A NODE card is an inexpensive multichannel I/O device designed at BNL which receives commands from the PLC and distributes these commands out to as many as 12 power supplies. The power supply statuses are also sent back to the NODE card and then onto the PLC from the NODE card. The control card controls which state the power supply is in and monitors the power supply faults and trips the power supply to a fault state if a fault occurs. This control card employs a micro processor to control the power supply.

The insertion power supplies must also interface with the quench protection system. There are connections made to the Quench Protection Assembly (QPA) and the Quench Detector. The power supply sends the power supply status to the QPA and any QPA faults are sent back to the power supply as well. The power supply output current is sent to the Quench Detector.